

MIRLIN Camera: Imaging the Heat of the Night

Astronomers at the Jet Propulsion Laboratory have built an infrared camera nicknamed MIRLIN (Mid-InfraRed Large-well Imager) to enable them to do a wide range of observations. Among these are studies of the temperature characteristics of the atmospheres of Jupiter and Saturn, investigations of how stars and planetary systems form and evolve, and how galaxies originate. The camera is a visiting instrument at three large telescopes: the 5 meter (200") diameter Hale telescope on Mt. Palomar, CA, the 3 meter (120") NASA Infrared Telescope Facility on Mauna Kea, HI, and the 10 meter (400"—33 feet!) Keck II telescope, also on Mauna Kea. Because it operates in a part of the light spectrum where two-dimensional detectors were not available until just a few years ago, it is helping to fill in crucial missing pieces in our understanding of a variety of astronomical objects.

Why Infrared?

Astronomical objects emit energy over a broad spectrum. Visible light has a wavelength range of 0.4 micrometers for blue light (1 micrometer is about 1/50th the diameter of a human hair or 40 millionths of an inch) to 0.7 micrometers for red light and is emitted by objects which have temperatures of many thousands of degrees like the sun and other stars. Information about the atoms that make up stars can be obtained by observations at visible wavelengths.

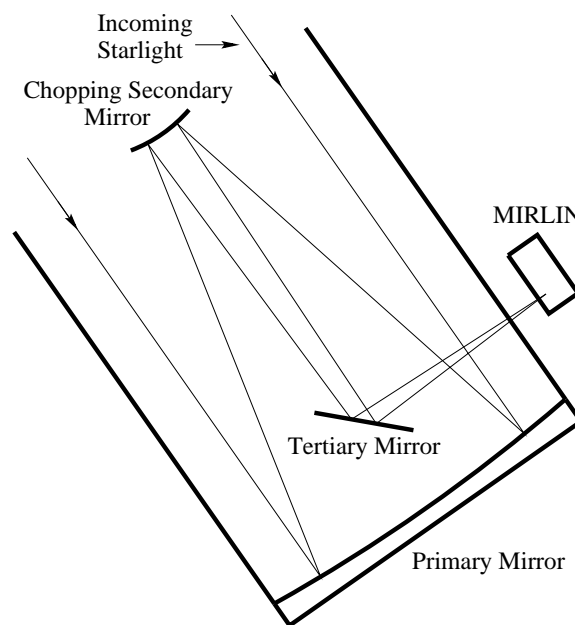
The infrared portion of the spectrum covers a much broader range of wavelengths. The mid-infrared, 5–30 micrometers, is where the planets and room temperature objects emit most of their radiation. (We can see the planets with our eyes because of the sunlight they reflect, not the energy they naturally emit.) Dust around still-forming stars glows brightly in the mid-infrared, and we can obtain information about complex

molecules such as hydrocarbons and silicates (familiar to us as soot and sand-like rocks).

Radio wavelengths (loosely defined as wavelengths longer than 1000 micrometers—1 millimeter) tell us still more information about a variety of molecules and other physical processes. By observing an object at a variety of wavelengths, scientists can piece together a coherent picture of what the object is and how it fits into our understanding of the universe.

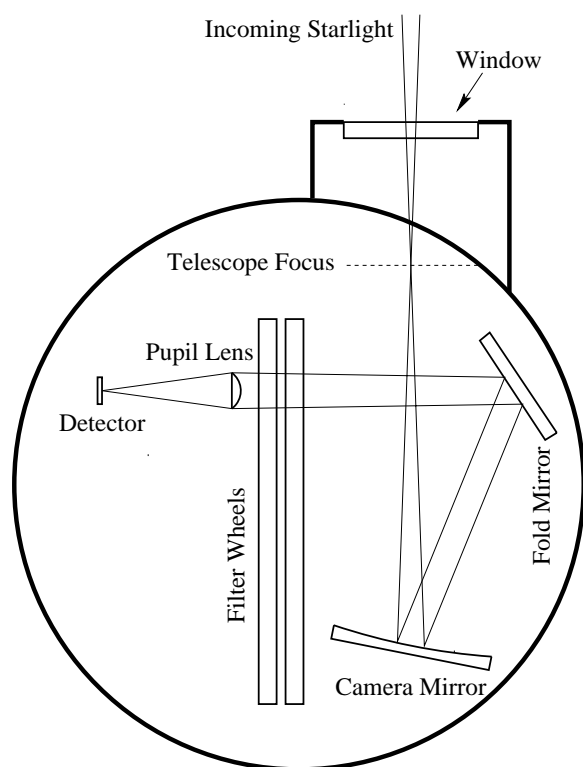
How MIRLIN Works

MIRLIN is much like the camera body of a 35 mm camera—it contains the “film” (the solid state detector) and all the controls (exposure time, etc.). The telescope is like the lens—by changing lenses (moving to different telescopes), different fields of view or other effects can be obtained. The following figure shows a sketch of how MIRLIN is positioned with respect to the Keck II telescope.



The heart of MIRLIN is an array of 16,384 infrared detectors made by Boeing in Anaheim, CA; these detectors are arranged in a

128×128 square. The detector material is silicon which has been intentionally contaminated with arsenic; such detectors are sensitive to mid-infrared “light”. MIRLIN’s optics are very simple: two elements—the camera mirror and the pupil lens—transfer the image produced by the telescope onto the detector (shown in the following figure). The field of view of the camera has been optimized to take advantage of the sharp resolution provided by these large telescopes.



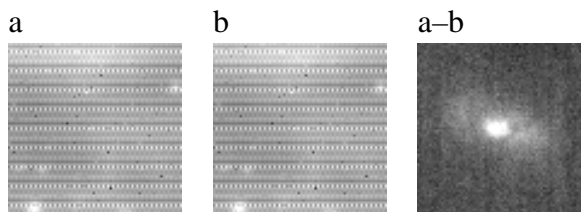
The entire camera is controlled by two computers. The first one provides an easy-to-use interface which allows the astronomer to select the wavelength, exposure time, and other observation parameters; it also processes and displays the incoming images. The second computer controls all the hardware in order to provide the requested observation.

Taking Images

Absorption by molecules in the Earth’s atmosphere, particularly water vapor, limits the wavelengths which can be detected by MIRLIN to several “windows”. Observations in the

mid-infrared are further complicated by the fact that any object which is near room temperature glows very brightly in this range, including the telescope and the sky—even the astronomer! In fact, observations at mid-infrared wavelengths have been compared to “observing in broad daylight with a telescope made out of light bulbs.”

To eliminate this overwhelming background from the data, observations are done by taking images which alternate rapidly between the object (completely invisible in image “a” below) and a blank region of sky nearby (image “b”). This “chopping” is performed by toggling the position of the telescope’s secondary mirror back and forth between two points; 5 times per second is typical. The background measured in image “b” is then removed from image “a”; the result is shown as the “a–b” image.



To Learn More About MIRLIN

MIRLIN was built at JPL by Dr. Michael Ressler with the assistance of Dr. Michael Werner, Dr. James Bock, George Reyes, Dr. Jeff Van Cleve (Cornell University), and Summer Undergraduate Research Fellows Helen Chou, John Petren, Warren Davidson, and Christianto Liu. Funding was provided by the JPL Director’s Discretionary Research Fund and the NASA Infrared, Submillimeter, and Radio Astronomy Program.

We invite you to visit MIRLIN’s World Wide Web site at <http://cougar.jpl.nasa.gov/mirlin.html> to learn a bit more about MIRLIN and to view a variety of images it has taken, including those of the newly discovered disk around the star HR 4796, where a solar system is believed to be forming.